*Huddled 'round the Flare*

# The HUMBLE WAY

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# HEALTH FOR ALL

DOUBTLESS the sage of ancient days who coined the proverb "an ounce of prevention is worth a pound of cure" never had a Kahn and Kline test and never donned a pair of safety shoes.

But very probably he would agree with the corps of doctors, nurses, and technicians of Humble Companies' Medical Division (who think his adage is mighty apropos) that good health is how you keep it.

That is why the Medical Division, with a vigilant eye, stands guard over the health of men and women working for the Humble Companies wherever they may be—in the swamps of Louisiana, the Everglades of Florida, the Monahans desert of West Texas, in Gulf Coastal waters, in Houston, Natchez, Baytown, Tampa, Abilene or Hobbs—in numbers of cities and hamlets, and field communities.

While every Humble employee has routine contact with the Medical Division and hundreds have felt its helping hand in a time of need, few indeed have had an opportunity to know the wide scope of work carried on under the Division's program.

Simply listed—one, two, three in cold bare print—the functions of the Medical Division are impressive. "Promote a high standard of health among employees; conduct pre-employment and periodic health examinations; recommend corrective measures in occupational health hazards; assist safety engineers and operating management in establishing safe working principles; conduct health education among employees; care for or cooperate with insurance carriers in industrial accident cases; advise with and recommend to management placement and transfers of employees according to their physical capabilities; advise and offer counsel on medical subjects to employees."

When you begin to fill in the blank spaces—read between the lines—you can understand something of the service this group performs.

Of course the Medical Division does neither claim, aspire, nor intend to play the role of family physician to Humble's more than 17,000 employees. A man's doctor is like his church—he must choose his own. However, the Division is interested in anything that makes for healthier, happier, and more efficient employees. Because, it has been proved that a sound industrial health program contributes to decreased absenteeism and increased efficiency of employees and is good business in dollars and cents savings to employees and to the Company.

Humble's medical program is so organized that it functions as a part of the essential medical service of the communities where Humble employees live and work—in cooperation with the medical profession in the communities and with the county and state health agencies.

Facilities of the Medical Division are available to every employee in the Company without discrimination. Whoever he or she may be—there is available such services as: a physical examination to determine where their capabilities may best be utilized; periodic check-ups; special examinations should conditions warrant; treatment of injuries occurring on the job; rehabilitation from such injuries should it be necessary; treatment of minor illness; counsel concerning illness requiring absence from work; medical advisory service; advice on job sanitation and, in Company field communities, on sanitary living conditions.

A complete medical record is kept for each employee from the date of his pre-employment examination throughout his association with the Company. Detailed statistics are kept concerning the frequency and severity of disease groups, as well as analyses of the causes of deaths among employees.

It is obvious that carrying out such a program would be impossible without the full confidence and cooperation of employees. Consequently the Medical Division's records of specific diagnoses and its relationship with employees in voluntary medical examinations and consultations are kept strictly confidential, and solely a matter between the Company doctors and the employee.

Naturally the Medical Division is headquartered in the Houston office, with a chief physician in charge. The medical staff includes six physicians, nine nurses, and seven industrial field nurses, four technicians, and a clerical force sufficient to handle the great volume of records and paper work necessary to give such service to more than 17,000 employees.

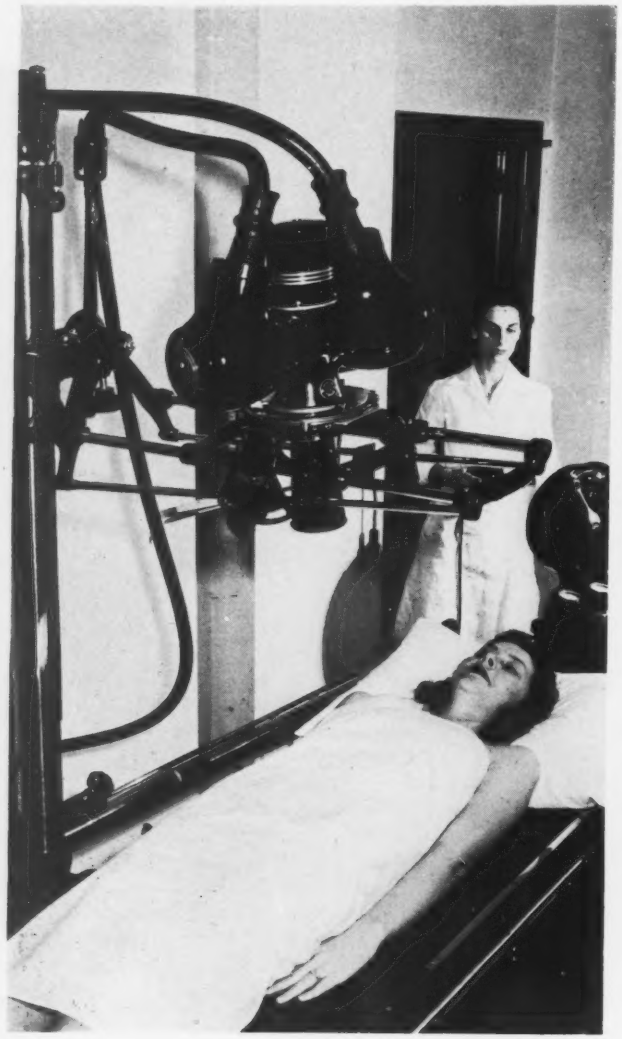
At Medical Division headquarters there is a completely equipped, modern clinic and laboratory staffed by carefully



ALMOST 60,000 CHECKS are mailed by Humble each month to royalty owners who have interests in leases where the Company buys oil and gas. (*Checks Go Out*, Page 20).

CHECKING IN for diagnosis and possible treatment, Houston Office employee gives her name to desk clerk. Nurse at left holds patient's medical record, will send it to physician who makes the examination.

X-RAY OF SPINE has been ordered for this Houston Office employee. Medical technologist gives last-minute instructions, will step through door in the background and press button in right hand to take picture.



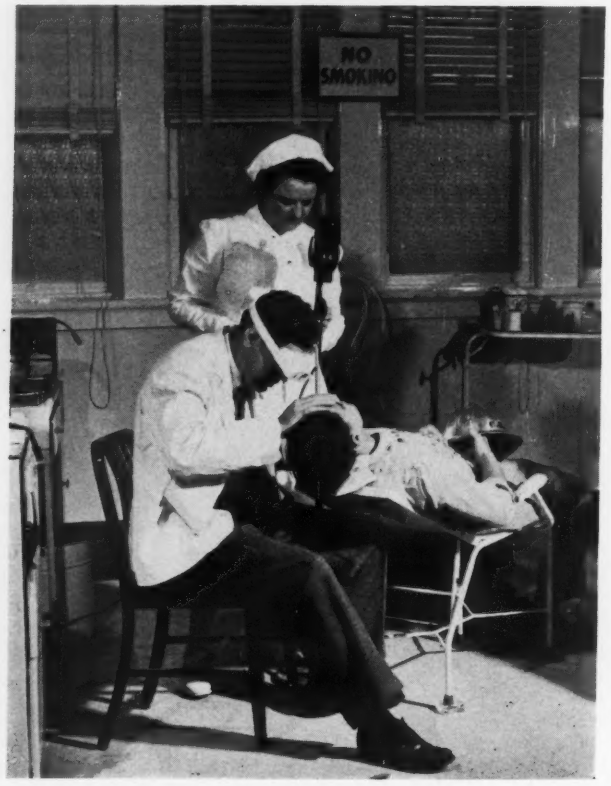
selected, competent personnel. Two of the Company physicians have their offices there. Another major part of Humble's medical organization is the Company clinic at Baytown refinery. Here three physicians head a staff which works on a 24-hour, seven-day week schedule to give aid and constant protection to the health of approximately 6,500 refinery employees.

These two headquarters are only a part of the Company-wide organization for health control. Since facilities must be adjusted to fit the needs and size of various employee-groups, it is obvious that the Company cannot maintain a complete clinical office everywhere it has employees stationed. At Baytown, where thousands of men and women are employed, provisions are by necessity more elaborate than at locations where the number of employees is limited.

However, distance from headquarters or smallness of the employee group to be served do not lessen the vigilance of these guardians of employee health. In addition to the full-time Medical Division organization, there are approximately 350 physicians of private practice located in outlying communities where Humble has production, pipe line, sales or other operations, who have been appointed by Humble's chief physician to do the Company's work on a fee basis. The work of these appointed physicians for the Medical Division is confined only to pre-employment examinations, special examinations initiated by the Company, and the care of industrial accident cases.

A recent addition to the Division's staff was a field medical examiner—a physician who devotes his entire time to traveling from one operating headquarters to another, wherever

FIRST AID for employee at Baytown refinery. Physician wears special eyepiece to find foreign body in process worker's eye, will wash cinder away with sterile water. Nurse stands by to hand doctor instruments.



groups of Humble men and women are employed, assisting them, where his services are wanted, in keeping check on their health and well-being. At this time the field examiner is engaged in conducting periodic physical examinations which will be available on a voluntary basis to every man and woman employed by the Humble Companies in field operations.

Then there are the field industrial nurses—seven of them—whose duties combine an assortment of tasks including various elements of personal and welfare work, teaching, public relations, industrial relations, first aid, and nursing. They serve as one of the field employees' contacts with the Company in cases of sickness. Their services are offered to employees, but not imposed upon them. Theirs is a task that calls for loyalty to duty at all times, at the same time demanding fairness and friendliness to the employee. They are at times the only point of contact with the sick employee or his family, for it is the nurses who visit in the home and have the opportunity of a warm, personal relationship with the wives and children of field personnel.

Oftentimes the field nurse conducts classes in first aid and other healthful living techniques for the families of employees in Humble field communities. Principally the field nurses bear the message of preventive medicine, healthful off-the-job living, to the employees' homes.

Working with the physicians and nurses, of course, are the X-ray and laboratory technicians, the physiotherapists, and other specialists who play their important roles in this closely knit team which makes up the Medical Division.

This team is available to any employee for medical advisory service, and within the limits of practicability, for diagnostic service. These services are widely used by Humble field employees particularly in illness of long duration, and those which present difficult diagnostic problems.

Preventive medicine, of course, is the backbone of the medical program—the techniques on a community basis that guard water and food supply, seek to prevent epidemics, to promote healthful and careful living and working habits, to prevent illness before it strikes. In order to accomplish these objectives, sanitary codes for field communities have been developed by the Medical and Civil Engineering groups. These codes provide for regular bacteriological analyses of water supplies; insect and rodent control; drainage; establishment of outdoor playgrounds; and other factors contributing to the better health and well being of the employee and his family living in the Company camp.

So important has this phase of the Medical Division's work become that at this writing plans are under way to secure the services of a full-time industrial hygienist—a sanitary engineer—to head a program which would seek to assure Humble people everywhere of the most healthful working conditions possible.

As a pioneer and veteran in the field of industrial preventive medicine, Humble's Medical Division has been functioning long enough to have faced most of the standard problems that arise. However, in an industry such as petroleum, where methods of finding, transporting, refining and selling are subject to the drastic alterations of technological advance, new problems concerning employee health, safety, and well-being are constantly arising.

X-RAY PLATE is held aloft after development by medical technologist. Below, physiotherapy relaxes sore leg muscles for Baytown refinery employee. Physiotherapist prepares his equipment for incoming patient.

THE LINE FORMS for typhoid shots at Stratton Production Camp. Employees look intently on as field nurse prepares syringe. Typhoid shots are offered to all employees and families annually.

MOTHER AND DAUGHTER combinations are familiar to field nurses around typhoid inoculation time.

This
over

TAKING PULSE of flu patient at his Production camp home is part of day's work for field nurse. Employee, fever thermometer in mouth, is unimpressed; keeping him in bed will be her biggest job.

In this respect, Humble continuously is engaged in study and research, mapping out new lines of procedure, new methods of approach to maintaining employee health.

The Division is constantly engaged in eliminating occupational hazards and protecting against occupational diseases. In addition to routine health examinations, it is the policy to make special examinations to determine the fitness of employees assigned to jobs where there may be special health hazards. Re-examinations are performed as needed.

However, most of the work done at Humble in eliminating occupational hazards and protecting against occupational diseases has been on specific toxicological problems.

Humble's Medical Division head is chairman of a Medical Advisory Sub-Committee of the American Petroleum Institute. This group, composed of medical representatives of many oil companies of the nation, is preparing a reference book on toxicology which will include all known information about the toxic effect of chemicals used or produced in the oil industry. The work is being carried out through a full-time research program at Harvard University School of Medicine. The reference book will include such data as safety precautions to be taken to avoid injury or illness from a specific hazard, treatment in case of injury or illness from this hazard, and other data of equal import.

The Medical Division, in conjunction with the compensation insurance carrier, is responsible for the treatment, care, and readjustment of industrial injury cases. An important feature of this responsibility is the follow-up on the return to work of these cases. Too, the Division advises concerning the placement of those with partial permanent disability where they can work safely and efficiently.

Particularly in cases of industrial injury, every precaution is taken to insure the injured employee of immediate attention from the best medical talent available.

However, where the average employee has contact most

fami-
time.

This reluctant youngster appears none too happy over prospect of receiving her annual booster shot.

"SAY AH-H-H!—and we'll have a look at those tonsils." Gentle, friendly handling by field nurse overcomes youngster's natural fear; mothers usually accompany children to nurse's office.

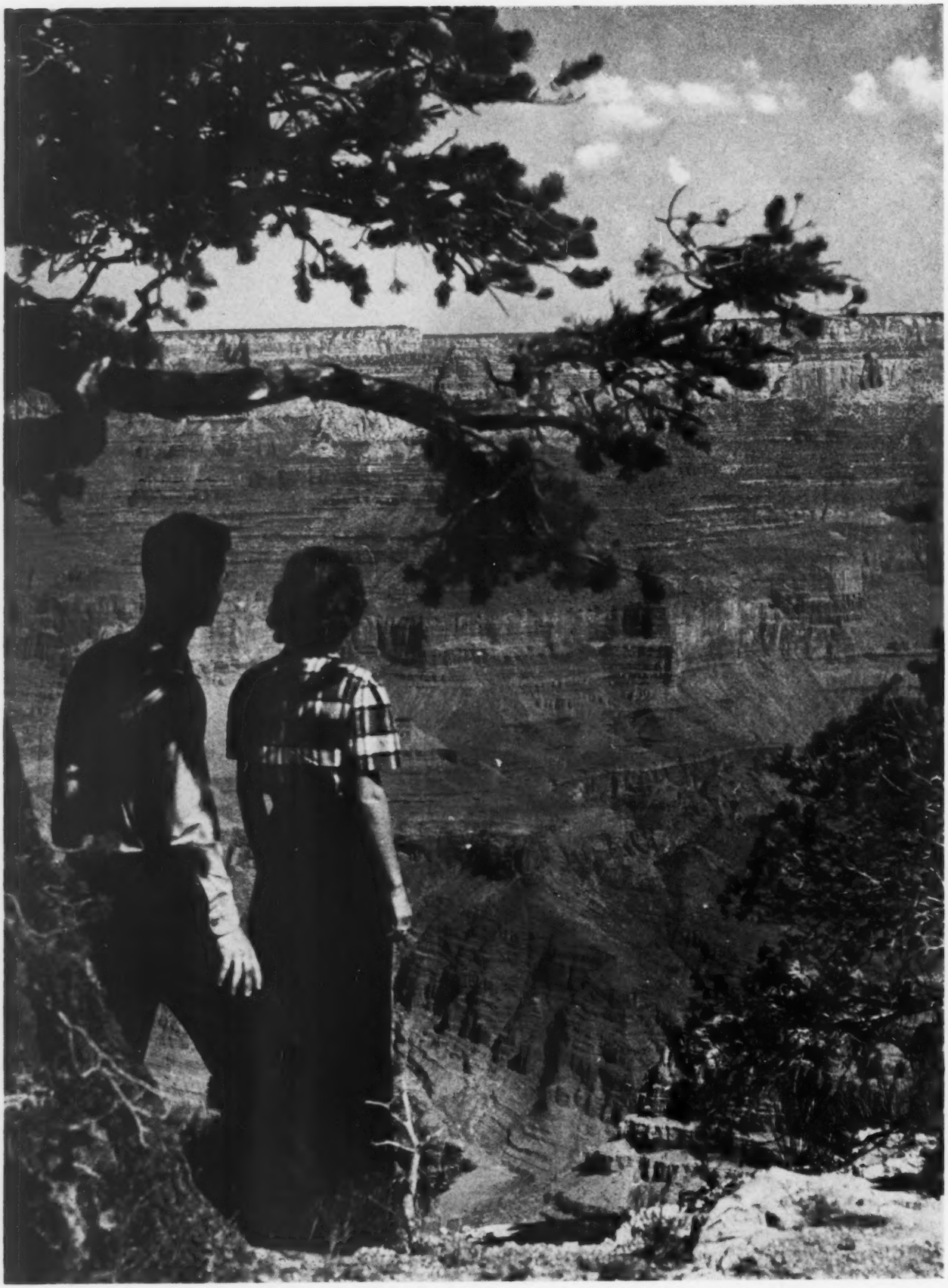
frequently with the Medical Division is through his pre-employment physical examination; his periodic physical check-ups; and through the Division's work in supervising the medical phase of the Company's sickness benefit program.

In virtually every Humble operating center where a large group of employees are headquartered, independent hospitalization insurance arrangements have been established. These hospitalization plans make available to employees and their families such insurance on a group basis at a reduced cost. One of the greatest contributing factors to the low premium rate offered by insurance carriers to most of the employee groups is the high standard of health prevalent among the membership. The Medical Division gains a great deal of satisfaction from the knowledge that its work, indirectly, may contribute to these low rates.

There are many ways that the Medical Division works with the public health agencies of the nation. For instance, for a number of years the Division has offered typhoid vaccine to all employees and members of their families. This is administered free of charge at locations where the Company has full-time medical personnel and under certain circumstances other vaccines and serums are given on request. Too, where practical and available, arrangements have been made with the Anti-Tuberculosis League to have free chest X-rays for all employees. Because of the nature of the League's program these X-rays usually are limited to heavy population centers.

It would be impossible to discuss—or even list—here all the numerous services performed by the Medical Division. Some, seemingly trivial, have doubtless saved lives. Others. recognized as essential to health and welfare of an industrial organization, have become commonplace from constant usage. But, whatever these services and duties may be, they all are contributing to the prevention of illness among Humble men and women, bearing out the premise of the Medical Division: that good health is how you keep it.

DOESN'T HURT A BIT! declares this plucky lad in the sailor cap, bearing up bravely under typhoid shot given by Stratton Camp field nurse. In field camps, nurse is the friendly guardian of family health.



# The Open Road

THE open road is calling to travel-hungry Americans. All over the land signs point to a great travel season this spring and summer.

Humble Touring Service is preparing to answer a larger number of requests for information than any previous season; tourist havens across the nation are laying plans to accommodate record crowds. By train, by plane, and by bus the tourists will go. But mostly they will go by automobile along the highways and trails that lead to natural wonderlands, to places of historic interest, to bustling seaside spots, to quiet mountain retreats.

In Texas, early spring's wildflower beauty is already inviting city dwellers out into the great open spaces; prompting them to bring picnicking equipment out of storage for week-end enjoyment. As spring's tempting balminess turns to summer and the vacation season blooms into full maturity the whirr of wheels across Texas will increase in tempo.

To Humble Touring Service falls the happy lot of providing many of these travelers with maps and directions for pleasant, carefree motoring; to thousands of Humble driveway salesmen the privilege of supplying the fine products and courteous service that will lead uncounted numbers of Texans and out-of-state visitors to proclaim that this summer's vacation trip was the most enjoyable they have ever made.

FISHING AND BOATING enthusiasts may find recreation facilities to their liking on lakes all over Texas, or along miles of Texas coastline if their preference runs to salt water and sandy beaches.

THE GRAND CANYON (left), the country's numerous seaside resorts, and Texas' own beautiful Rio Grande Valley are some of the spots where heavier-than-usual tourist crowds are likely to go in 1947.

# Weight *is the Key*

FLOWING through a 5/32" choke, X well in the Blank Field produced 388 barrels of 33 degree gravity oil per day with a tubing pressure . . . . . ."

So begins a typical account of a new well's performance as reported in the oil section of your daily paper. You know, from reading that much of the report, that the well is capable of producing 388 barrels of oil daily through a small constriction, or "choke," 5/32 of an inch in diameter. But what does the 33 degree gravity mean? What is there about this oil that sets it apart from 25 or 40 degree gravity crude?

The answer is: its weight. Oil, you see, is weighed by gravity numbers, or degrees, just as people are weighed in pounds and ounces.

At first, specific gravities were used; the weight of a given volume of oil was expressed in relation to an equal volume of water at a given temperature. Since oils are, with rare exceptions, lighter than water, their specific gravities are less than 1.0, the number assigned to pure water at 60 degrees Fahrenheit. A light oil, for example, may have a specific gravity of 0.769; a heavy oil, 0.951. A few crude oils are actually heavier than water, but these are departures from the rule.

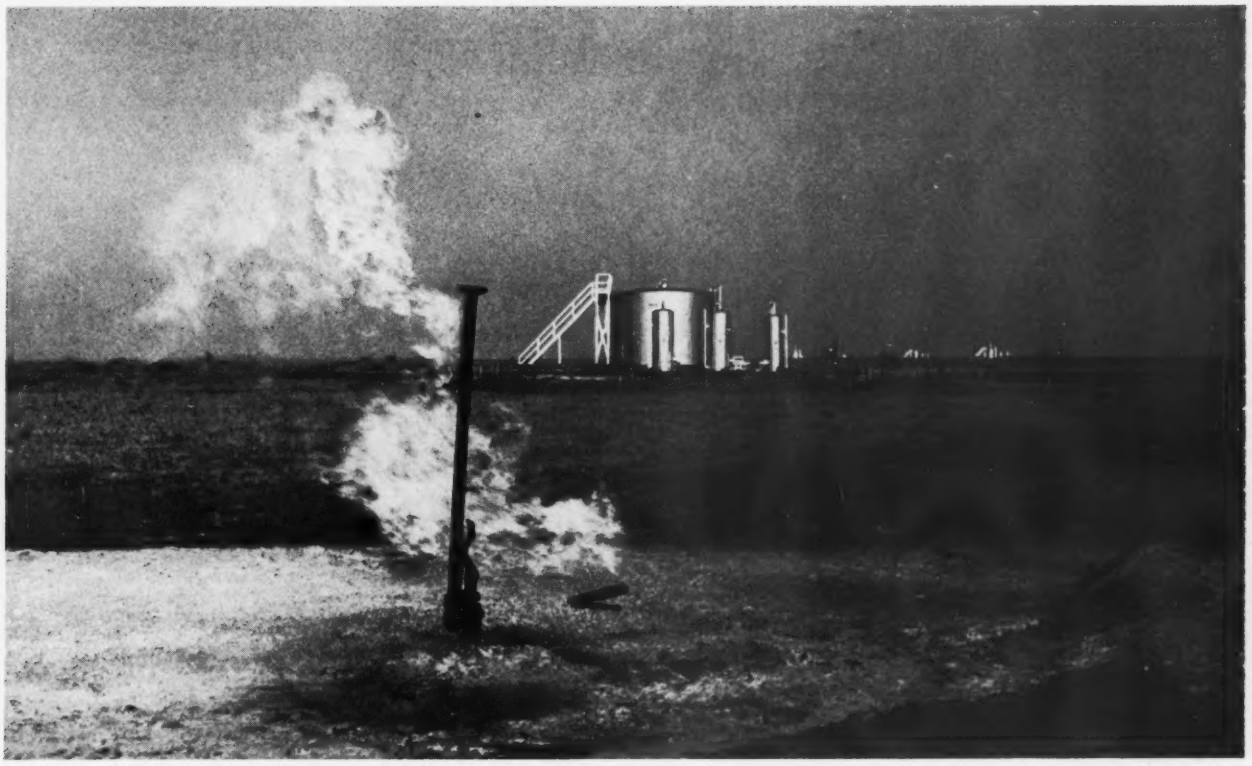
Since decimal fractions are less workable, less easily understood, than whole numbers, a man named Beaume worked out another system for weighing oil by the gravity method. The system bears his name, although it was later shortened to Baume.

Measuring instrument for the Baume system is a hydrometer. It is a long, slender glass tube marked off in degrees and tenths of degrees of gravity and having at one end a bulb loaded with mercury and lead shot. The principle of the measurement is simplicity itself. Placed in oil or other liquid, the hydrometer sinks to a depth determined by the liquid's weight, going deeper into a light liquid than it does into a heavy one. Readings are taken from the hydrometer's gravity scale at the surface of the liquid. Each sample's temperature must be taken as it is weighed, and a conversion table is provided for correction to 60 degrees Fahrenheit.

Successor to the Baume system, and now standard for the entire petroleum industry, is a method with a revised hydrometer scale as set up by a committee of the American Petroleum Institute. Weights are now assigned by numbers or degrees A.P.I. Large numbers indicate light oils; the larger the number, the lighter the oil. A 40 degree A.P.I. crude is relatively light; 20 degree crude is quite heavy. Gasoline may run from 50 to 70 A.P.I. In the A.P.I. scale, an oil having a gravity of 10.0 weighs exactly as much as distilled water; it has a specific gravity of 1.00. Our 33 gravity crude, then, is about medium weight, as oils go.

Weight, which may range in crude oils from as low as 5 A.P.I. to as high as 65, is generally taken as an index of the oil's character and usefulness. In this age of high octane numbers and special light fuels, poundage is no more desirable in crude oils than it is around the human waistline. As a rule, light oils (those of high gravity) have a higher gasoline content than heavy oils and are therefore much sought after; heavy, or low gravity, crudes may be assumed to contain relatively more asphalt and other heavy products.

GAUGER USES HYDROMETER to weigh crude oil at the lease tank. Tip of hydrometer protrudes above surface of sample as instrument sinks to depth permitted by oil's weight. Taken in degrees of gravity, weight is one index of character, usefulness; generally affects prices.



HUNDREDS OF OIL FIELD FLARES ARE BEING SNUFFED OUT AS HUMBLE GAS CONSERVATION PROJECTS ARE COMPLETED.

# *Farewell to* FLARES

By HARRY PISTOLE and HARRY ARENDT
*Reservoir Engineers*

## Humble leads in aggressive post-war program to conserve and utilize casinghead gas from oil wells

THE brilliant flares that have for so long lighted the Texas plains are fast disappearing from Humble leases as the Company maintains its position of leadership in the conservation of casinghead gas.

Casinghead gas is the natural gas produced with oil from oil wells and as such performs its primary function in aiding in the production of oil. After it has been produced, it is potentially valuable if there are sufficient quantities and a market exists, or if other economic factors are favorable for its further utilization. Gas which is produced only from gas wells where oil is not present is not ordinarily flared because there is usually no reason to produce it at all unless a market exists or unless cycling is practicable. Moreover, the flaring of such gas has been prohibited by state law.

Company leadership in gas conservation is in accordance with the statement made recently by a Director of the Humble Company at a Railroad Commission Gas Conservation hearing in Houston: "Conservation of oil and gas is essentially an engineering problem and must be guided by the results of engineering investigation. The policy of Humble Oil & Refining Company in the conservation of casinghead gas is in general accord with those engineering principles and recommendations set out by the Gas Conservation Engineering Committee, State of Texas, appointed by the Railroad Commission. This policy includes the principles of (1) completing and operating oil wells and reservoirs in such a manner as to result in a minimum production of casinghead gas and maximum efficient oil recovery, and (2) marketing, consuming, or returning to the producing reservoir the produced casinghead gas wherever such disposition is economically feasible. In those cases in which it it not feasible or practical to return gas to the reservoir, the solution to the problem is dependent on the availability of markets for the gas."

The first of the two principal methods of reducing the amount of flared casinghead gas is to use those well completion and operating practices which will minimize the amount of gas produced with each barrel of oil. This is so closely tied in with efficient production of oil that Humble has used every known means to apply this principle. Its success is shown by the fact that less than five per cent of Humble production is being taken from wells with gas-oil ratios higher than the field penalty ratio set by the state regulatory body. Very little reduction in casinghead gas production is possible from changes in Humble's operating methods, because these methods are at peak efficiency. The second principle of "marketing, consuming, or returning to the formation the produced casinghead gas" is, therefore, the one to which Humble has turned for further gains.

The idea of marketing would seem very simple, but a brief

look at the background of the natural gas industry indicates difficulties.

The natural gas industry of the United States began in 1821 when a well was drilled at Fredonia, New York, expressly for the purpose of obtaining natural gas. This was 38 years before Colonel Drake drilled the first oil well at Titsuville, Pennsylvania. From 1821 to 1889, the demand for natural gas was increasing much more rapidly than was the supply. By 1889, known gas pools (centered in the northeastern United States) were nearing exhaustion and during the next 15 years manufacturers began converting back to coal.

In the interval from 1904 to 1919, important gas discoveries, including the great Texas Panhandle gas field, greatly increased gas reserves. From 1919 to the present, discoveries have steadily added to the reserves, especially in the Southwest, so that present supply in this area is greater than the demand. In addition to the oversupply situation, Southwestern reserves also suffer an additional price disadvantage, among other things, because they are so far away from the great eastern, midwestern, and West Coast population and industrial centers. This great distance gives gas from other areas a price advantage at least equal to the additional transmission costs involved.

Partially as a result of the oversupply and long distances, gas at the lease in Texas brought only 2.5 cents per thousand cubic feet in 1943 in contrast with 12.3 cents in West Virginia and 6.5 cents in California. The handicap of this low price in the average oil field is apparent when it is considered that the average well in Texas produces 15 to 20 barrels per day of oil and 18,000 to 30,000 cubic feet of gas per day. At the average price of 2.5 cents, the producer would receive only 45 to 75 cents per day for each well. Since the cost of a gas gathering system and compressor plant, plus operating costs, must be paid out of this small amount, the conservation of gas in many fields is impractical.

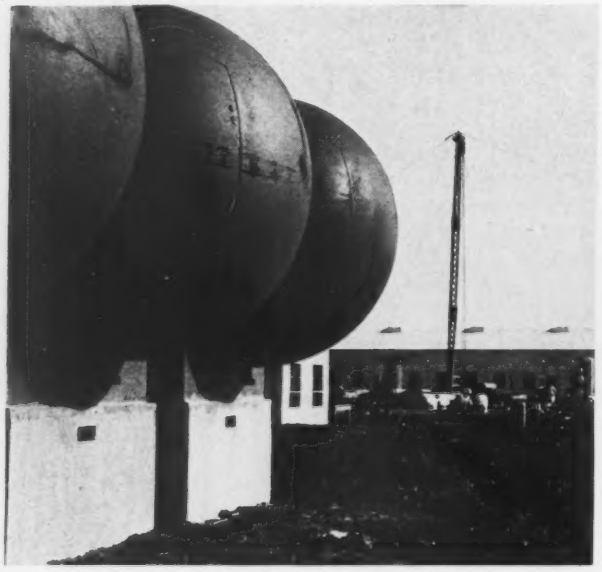
The industry believes that an additional difficulty is presented by the Federal Power Commission which is charged with the regulation of trunk line transportation of natural gas and of the sale for resale of natural gas in interstate commerce. Although the industry generally feels that the act under which the Commission operates specifically forbids interference with the producer and gatherer of natural gas, and the field price at which he sells his gas, the Commission has adopted an aggressive policy which threatens to interfere with the producers' operations not only in gathering and selling his gas but in such related activities as the production of oil.

In spite of the difficulties in economically conserving casinghead gas, from the time of its organization Humble has actively sought markets and other outlets for its gas. Other outlets include projects for pressure maintenance, repressuring, and gas cycling as well as use for drilling rig fuel and lease use for pumping, gas lift, and consumption in employee field communities. Also, wherever practical, the Company has built gasoline plants to extract the liquids from the gas, or has contracted with operators of other plants for such processing. In some cases where no other market existed for the gasoline plant residue gas, it has been sold to carbon black plants.

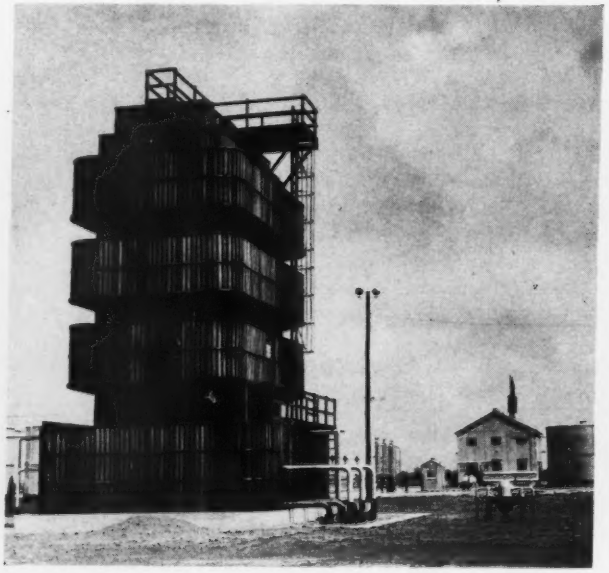
Humble's experimental gas repressuring project in the Olney Field, North Texas, in which gas injection was begun in January, 1930, was one of Texas' earliest projects to test the possibilities of this type of operation. Purchased gas was injected into the small, completely depleted Olney Field until reservoir pressure was built up to nearly the original level. The field was shut-in for two years and was then produced. Before repressuring began, the field had produced 349,140 barrels of oil; repressuring operations yielded a total of 202,889 additional barrels to increase the yield 58 per cent. Although the field was too small for the operation to be of direct economic importance, the fact that it had been completely depleted before repressuring makes it of considerable interest as it is one of the very few fields for which an exact amount of additional oil recovery can be fixed.

Only three months after the start of the Olney project, Humble started another and very much larger Gulf Coast repressuring project in the Sugarland Field. In this case, gas has been and is injected into the existing gas cap in order to cause gas cap expansion and aid the rather weak water drive

PRODUCT STORAGE TANKS are finished, but other work, slated for late summer completion, goes on at Anahuac Natural Gasoline Plant.



COOLING TOWER STANDS out at Amelia repressuring plant, where injection of previously vented gas was started late last year.



in displacing oil from the reservoir. As the project was begun very soon after the field discovery, an exact figure on the additional oil recovery is impossible, but even conservative estimates indicate a substantial payout. Gas has been injected at an average rate of approximately two million cubic feet per day, except for short periods when the water drive was adequate at the lower rates of production in effect.

Another interesting case was the start of pressure maintenance in the Hilbig Field in October, 1933, only eight months after field discovery. Gas injection has been into the top of the structure in order to maintain pressure and change from dissolved-gas drive to the more efficient expanding gas-cap drive. Present estimates indicate that oil recovery will be increased approximately 60 per cent by return of gas to the producing formation.

In December, 1941, Humble started pressure maintenance operations in the Upper Frio sand of the Lovell Lake Field. This reservoir has an unusually thin oil column overlain by a relatively large gas cap. The very thin oil layer indicated that it would be impossible to limit casinghead gas production to normal quantities. The cost of injecting the exceptionally large quantity of gas, averaging 60 million cubic feet per day, at an injection pressure of 3,100 pounds per square inch, is held down by the high compressor intake pressure of 1,300 pounds per square inch. Injection of nearly two million cubic feet per day into the Lower Frio sand was begun in October, 1946, to increase oil recovery from that reservoir.

Humble also has small repressuring operations in the Rock Crossing, South Vernon, Voth, Loma Novia, and Pampa fields.

During the prewar period, Humble was active in erecting several natural gasoline plants to strip the liquid fraction out of casinghead gas. At the beginning of the war, the Company operated eight plants: three in the East Texas Field, and one each in the Dickinson, Conroe, Flour Bluff, Heyser, and Tomball fields; and was part owner of the plant in the Pledger Field operated by Danciger Oil Company. Several other plants had been built and sold or shut down when the supply of casinghead gas in the nearby fields was exhausted.

In addition to operating natural gasoline plants Humble also sells casinghead gas from the following fields to the gasoline plants of other operators: Hawkins and Pruitt in the East Texas division; Hardin in the Gulf Coast division; Pampa, Archer, Wilbarger, and Wichita County fields in the North Texas division; East White Point, Plymouth, Stratton, and Sweden in the Southwest Texas division; and Foster, Fullerton, Goldsmith, Kermit, McElroy, North Ward-Estes, Penwell, Seminole, Wasson, Arrowhead, Eunice, Hobbs, Langlie, Paddock, Penrose, and Vacuum in the West Texas division.

Humble also built before the war and is today operating the Tomball, Pledger, and Lirette-Montegut gas systems which handle a total of 180 million cubic feet per day. While a majority of the gas handled by these systems is from gas wells, a very appreciable amount is conserved casinghead gas.

The severe materials shortages during the war sharply curtailed construction of compressor plants for gas injection, of gasoline plants, and of compressor plants and transmission lines to permit casinghead gas sales.

When the war ended, Humble made a complete survey of all its flared casinghead gas in order to conserve the gas in all fields in which it was economically possible. As a result, the Company has embarked on a very far-reaching gas conservation program. The survey showed that Humble was producing approximately 408 million cubic feet of casinghead gas with 210 million cubic feet, or 52 per cent, being flared. The 198 million cubic feet utilized reflected the results of the prewar program.

A current summary shows that since the war a definite program has been implemented for complete utilization of gas from 22 fields (nearly all facilties now complete or under construction) which were venting 110 million cubic feet per day. This does not include the large Humble-Quintana plant in the Tomoconnor Field (25 million cubic feet per day, cost $3,000,000) for which the contract has been let. Humble has a 50 percent working interest in several large leases in the field, but all these leases are operated by others.

LINE OF COMPRESSORS at Lovell Lake increase pressure of large quantity of casinghead gas for injection into the producing oil sand.

PLANT OPERATOR TAKES readings to insure proper pressure maintenance for casinghead gas injection at Amelia conservation plant.

The 110 million cubic feet to be saved in the 22 projects will reduce the amount of flared gas by 52 per cent, and increase total utilization to 298 million cubic feet, or 75 per cent of Humble's produced casinghead gas. Flared gas will be reduced to about 100 million cubic feet a day. Of this amount, 69 million cubic feet per day are included in 27 additional projects still in the planning stage. Development of a definite program for these fields would increase Humble's casinghead gas utilization to 367 million cubic feet per day, or 90 per cent.

Of the remaining 31 million cubic feet flared, seven and one-half million cubic feet is in fields in which Humble is not the major operator. The Company has expressed itself at Railroad Commission hearings as being willing to cooperate with other operators in any practical gas conservation program in these fields. Fields in the early stages of development account for seven million cubic feet of flared casinghead gas. and present information as to the quantity of gas that will eventually be available is too indefinite to permit planning of a program. The remaining gas is from fields in which the very small quantity, high sulfur content, remote location, or other factors make economical conservation impossible.

At present, 14 of the new projects are complete and are conserving 62 million cubic feet of gas per day. The largest and most recently completed of these is the Clear Lake compressor and high pressure natural gasoline plant in the Gulf Coast division which went into operation March 14, 1947, at a cost of approximately $2,250,000. A total of 32 million cubic feet per day of casinghead gas and 19 million cubic feet of gas-well gas will be stripped of natural gasoline and the residue gas delivered to the Tomball Natural Gas system. Seventy-one per cent of this casinghead gas was formerly flared in the Friendswood (Webster) Field in which Humble produces approximately 45,000 barrels of oil per day from all but three of the field's 207 wells. Another 22 per cent of the casinghead gas is from the Dickinson and Gillock fields and was formerly stripped at the Dickinson-Gillock low-pressure gasoline plant and the residue gas flared. The low-pressure plant has been replaced by a compressor installation to deliver the gas to Clear Lake. The remaining 7 per cent of casinghead gas was flared in the East Clear Lake Field. A gathering system, compressor, and gas line to the Clear Lake plant is now in operation. The 19 million cubic feet of gas-well gas is from the Halls Bayou well and from Dickinson wells and was previously delivered to the Tomball Natural Gas system without stripping.

Injection of the previously vented 2.7 million cubic feet per day of casinghead gas into the gas cap of the Amelia Field was begun December 1, 1946. Humble operates 99 of the 104 producing wells, and invested $165,000 in plant facilities for this project. Reservoir studies had indicated that the very strong water drive was forcing the thin layer of oil up into the gas cap, which would result in decreased oil recovery. Gas injection was started to prevent this loss of oil.

Oil production at the North Katy Field is confined to very narrow intervals around the edge of the great Katy gas field. Humble produces 1.150 barrels per day from 31 of 40 North Katy oil wells. Facilities to handle the eight million cubic feet of flared gas were constructed in the Katy Cycling Plant at a cost of a half million dollars and placed in operation late last year. The gas is processed in the gasoline plant of the Katy recycling unit with approximately 4,400 gallons of gasoline recovery per day; the residue is sold to Tennessee Gas and Transmission Company. Earlier reference was made to the very large gas injection program at Lovell Lake. In addition to the injected gas, 4.7 million cubic feet per day of low-pressure gas was formerly flared on the leases in this field. Facilities to gather and compress this gas for delivery to the Tomball Gas system were installed at a cost of about $170,000 and placed in operation in May, 1946.

In the Stratton Field in Southwest Texas, 3.3 million cubic feet of flared gas is being gathered for delivery to Chicago Corporation's gasoline plant where it is stripped and the residue is compressed for injection into the large gas cap. Since Stratton is essentially a gas-cap-drive field with no effective water drive, the gas injection should add materially to the strength of the producing drive and increase oil recovery.

In Louisiana, Humble has completed new casinghead gas conservation installations in six fields: North Crowley, North Tepetate, Chalkley, Good Hope, Roanoke, and Paradis. The largest of the Louisiana projects was completed in April, 1946, at North Crowley for the compression of nearly 9 million cubic feet per day of casinghead gas. A seven-mile lateral line was built to tie into Humble's new 65-mile-long Pecan Island gas line which in turn ties into Interstate Natural Gas Company's 16-inch West Baton Rouge line. Sale is to Interstate. Estimated cost of the gathering system, compressors, and lateral line is $390,000.

The North Tepetate installation, consisting of individual high-pressure separators and gathering system, handles a little more than one-half million cubic feet of casinghead gas and 18 million cubic feet of gas from gas wells. A Humble-operated plant dehydrates the gas before delivering it to the Interstate line.

At Good Hope, high-pressure separators and a gas gathering system were installed to handle about one million cubic feet of gas per day for sale to United Gas Pipe Line Company and delivery to its line in the field. A similar installation was made in the Paradis Field for sale of nearly two million cubic feet to United.

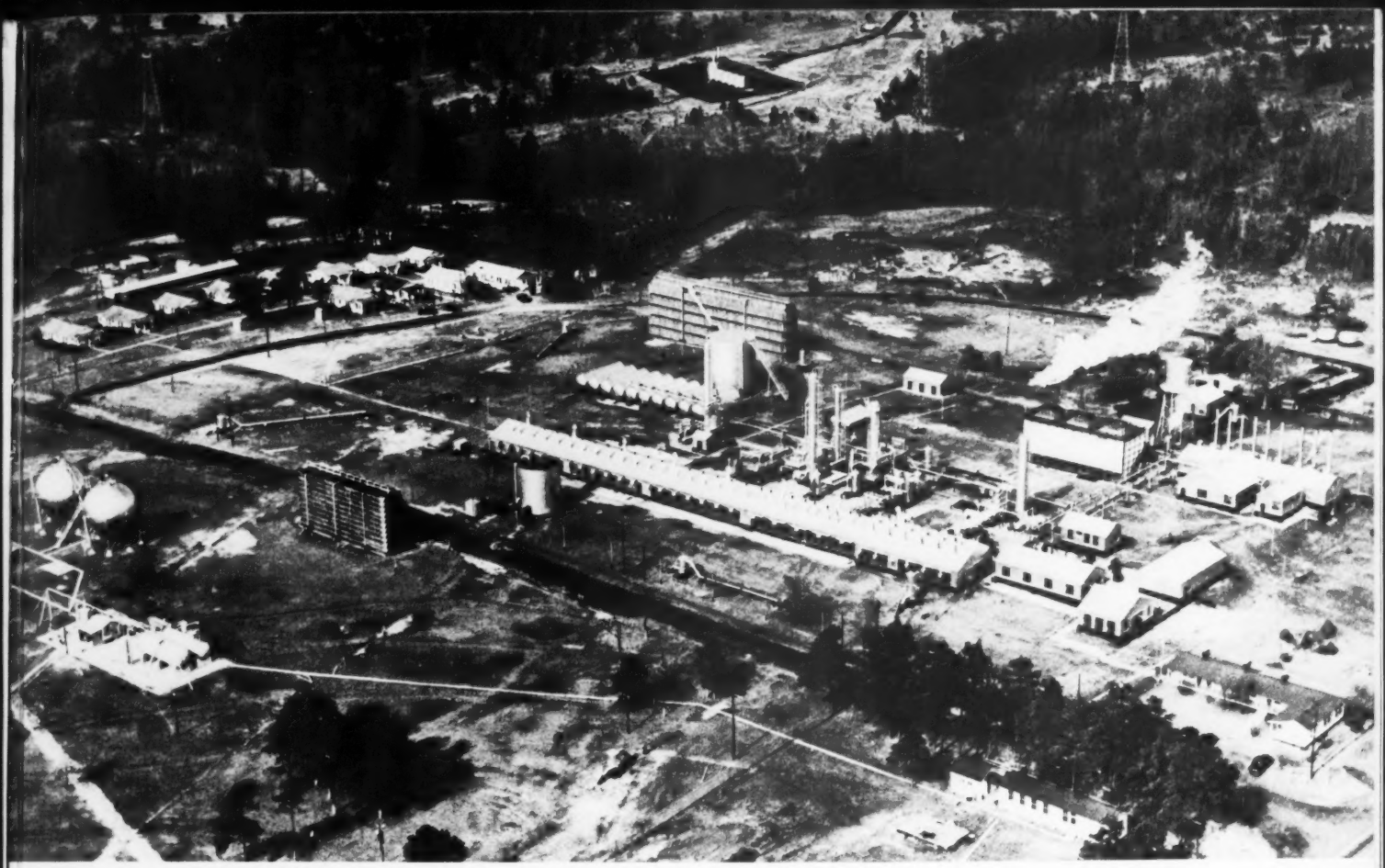
In Humble's Chalkley Field, four million cubic feet of casinghead gas is now being injected into the producing sand as a suitable storage measure, because there is no satisfactory market. Estimated investment is $160,000.

The Roanoke gathering system and compressors costing $78.000 conserve 1.7 million cubic feet per day of casinghead gas that was formerly flared. The gas is now sold to United.

Early this year, Humble started construction on a casinghead gasoline plant at Anahuac to process approximately 22 million cubic feet of Humble flared gas plus approximately 20 per cent more from the other operators in the field. The gasoline recovery is estimated at 30,000 gallons per day. The plant, scheduled to begin operation this fall, will cost nearly $2,500,000.

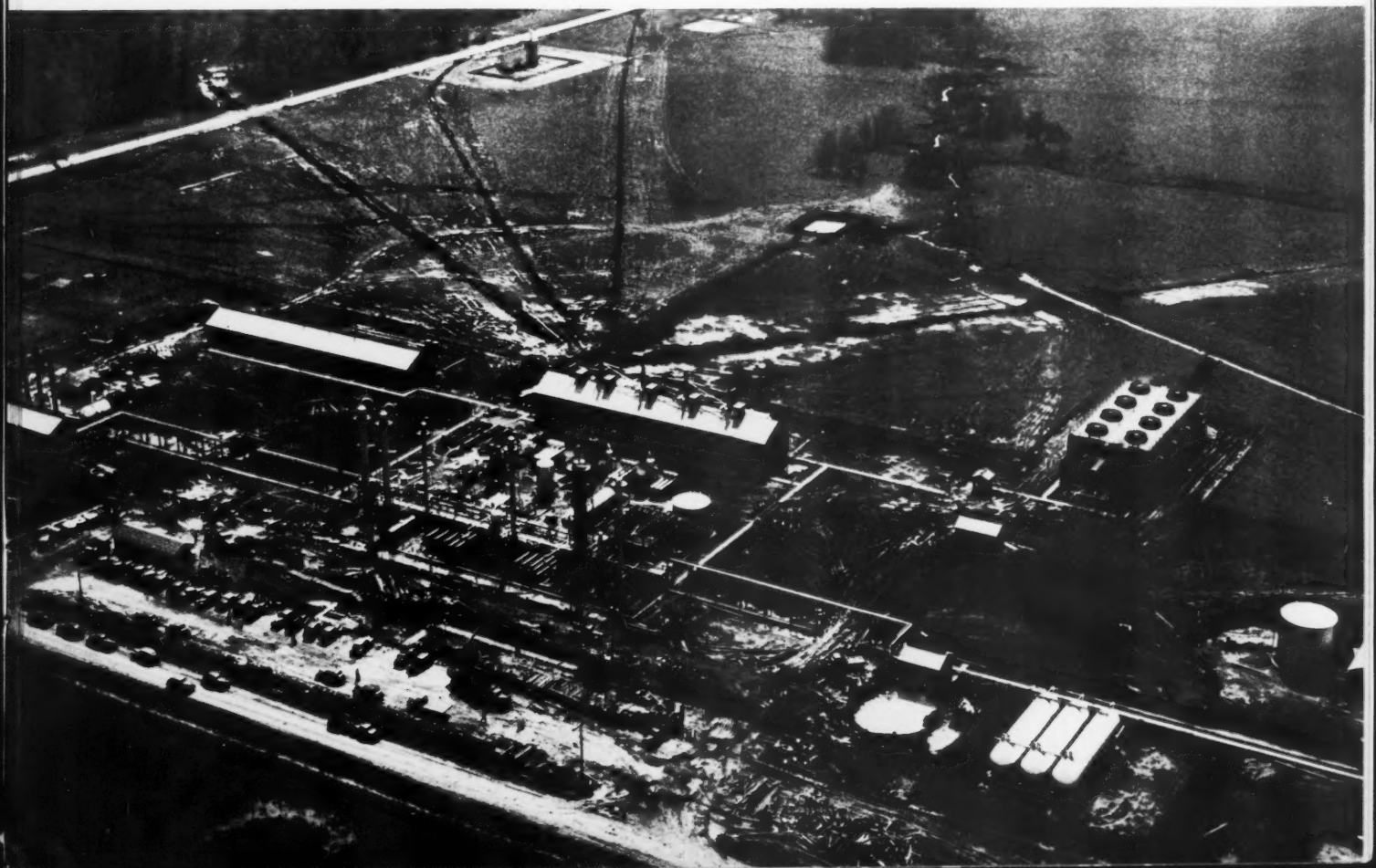
Since the end of the war, Humble has completed projects in 14 fields at a cost of more than four million dollars. The resulting saving of 62 million cubic feet per day has increased the Company's casinghead gas utilization to 64 per cent. When the projects for which definite plans have been made are completed, the post-war cost to Humble of gas conservation projects will be approximately 10 million dollars. This includes Humble's 50-per cent share of the Humble-Quintana plant at Tomoconnor.

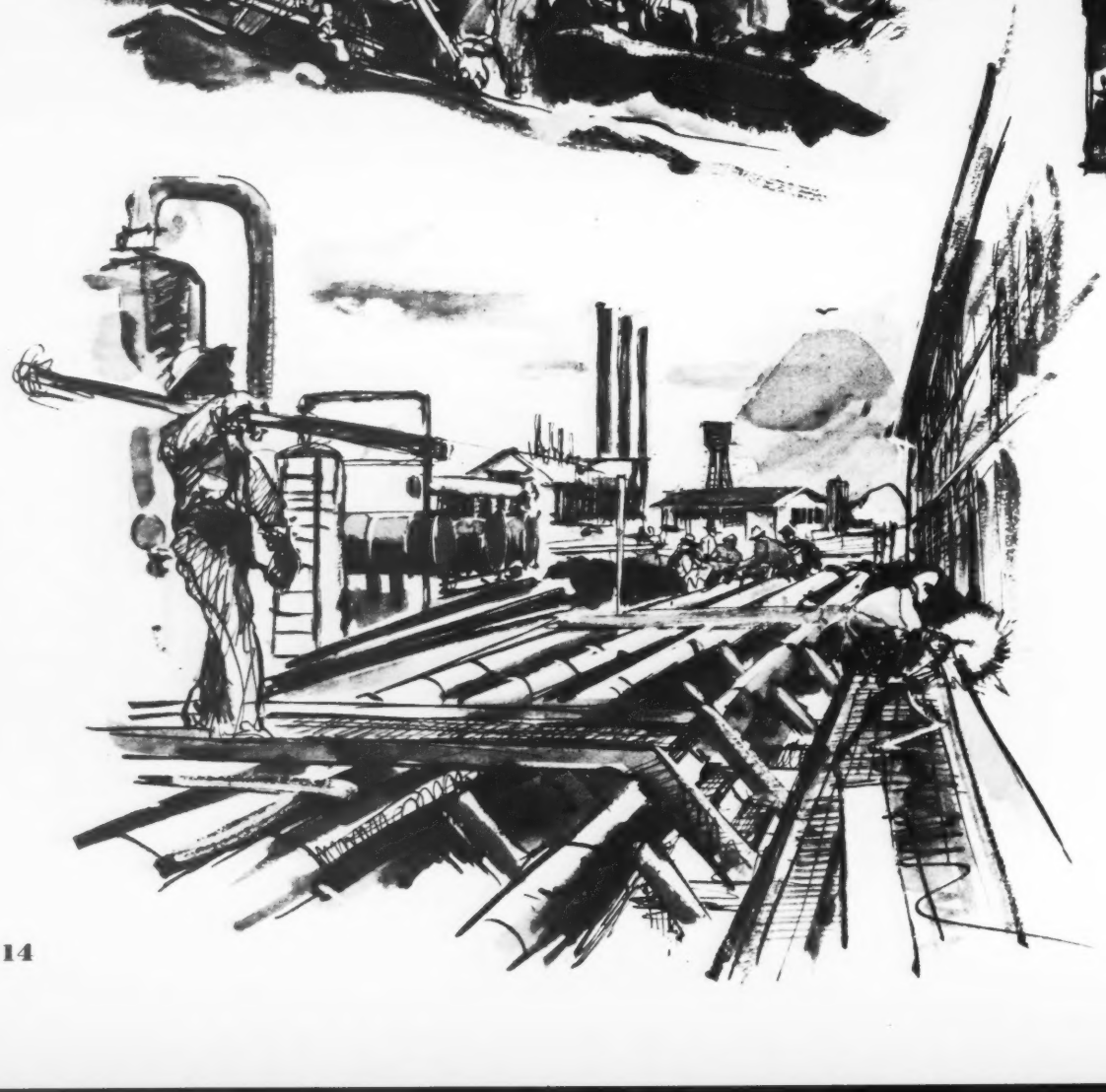
Completion of a program for the fields still in the planning stage will add a large amount to this investment, and will reduce to a bare minimum the amount of casinghead gas flared at oil wells operated by Humble.



KILGORE PLANT IS ONE OF THREE HUMBLE UNITS PROCESSING EAST TEXAS CASINGHEAD GAS SINCE THE EARLY THIRTIES.

NEWLY LAID FIELD LINES CONVERGE ON CLEAR LAKE PLANT, OPENED IN MARCH WHILE CONSTRUCTION WORK CONTINUED.



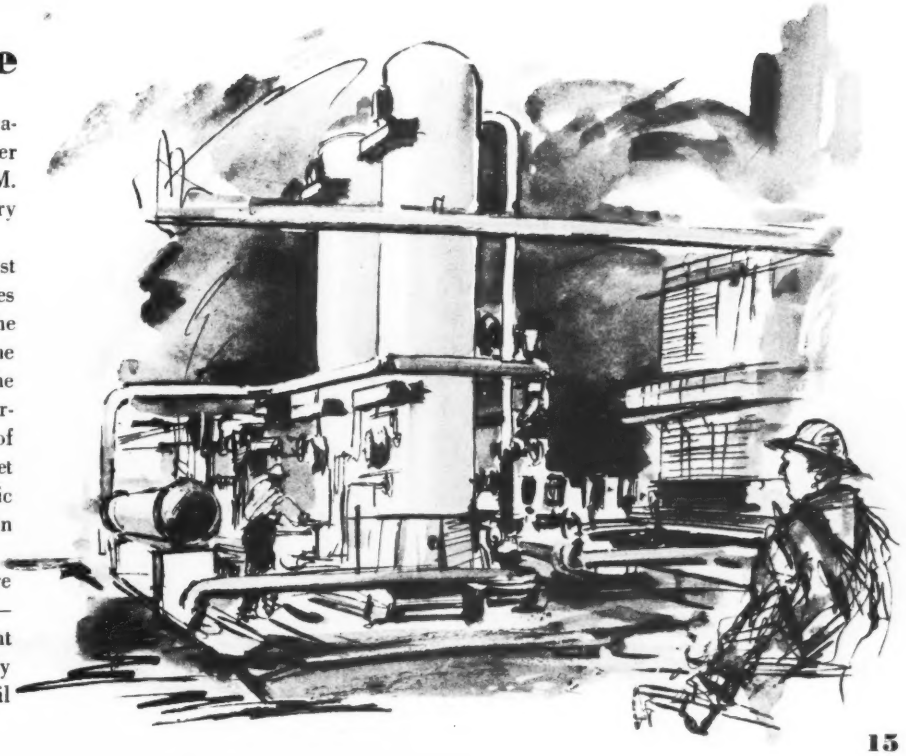


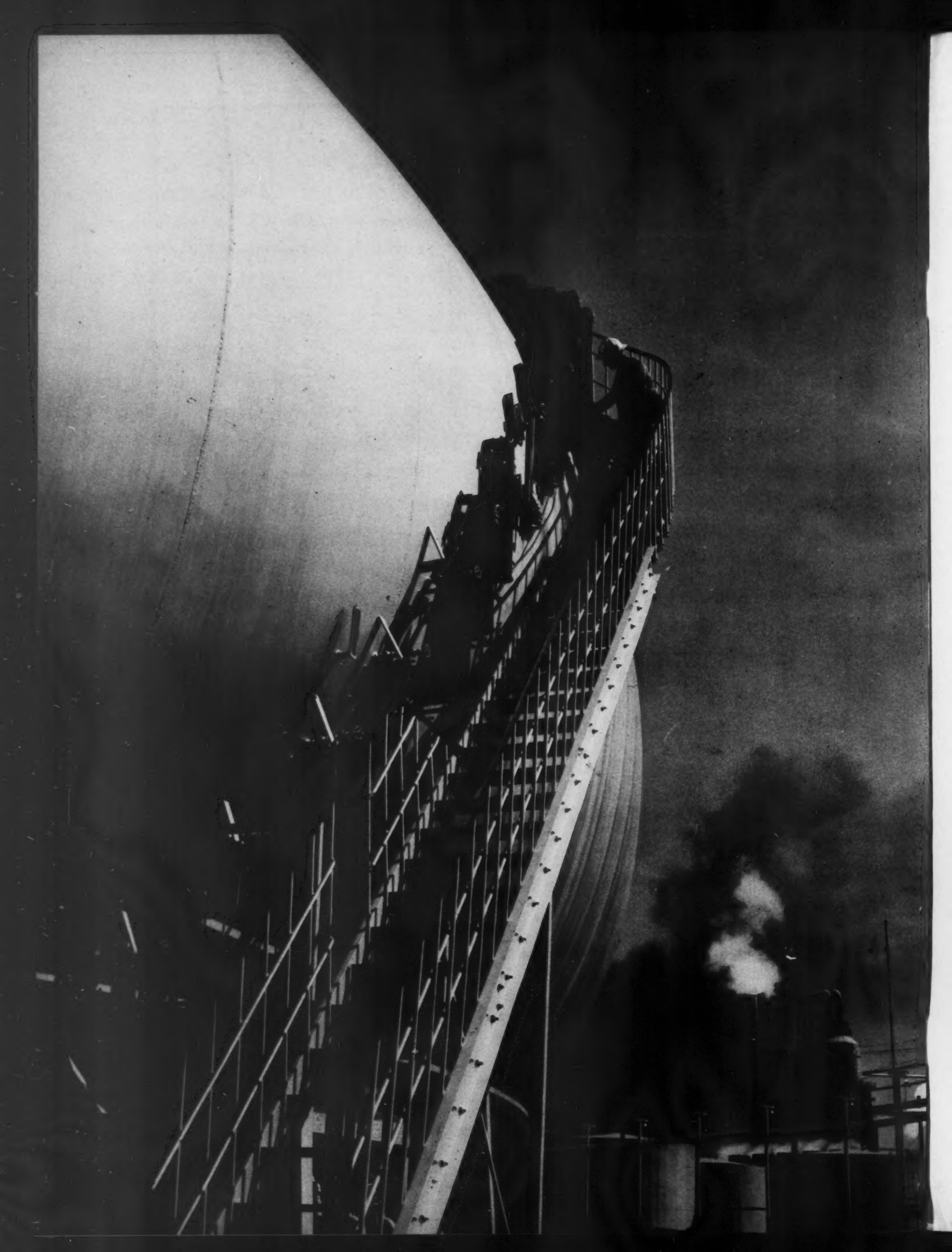
# Built to Conserve

From among a number of gas conservation projects the Humble Company had under construction early this year, Artist E. M. Schiwetz selected two for this series of dry brush paintings.

The struggle of men and machines against time and mud on the flat Coastal prairies between Houston and Galveston inspired the paintings of the Clear Lake Natural Gasoline plant under construction, top and left. The plant was completed in March and is currently recovering about 36,000 gallons of liquid fuel daily from 19 million cubic feet of gas-well gas and from 31 million cubic feet of casinghead gas previously flared in nearby oil fields.

The unit at right is the trim low-pressure gas system added at Katy Cycling plant — 30 miles west of Houston — to conserve eight million cubic feet of casinghead gas daily which had been flared in the North Katy oil field.





# Storage Tanks

**Storage tanks serve oil industry well, are necessary to continuous operation. Improved designs have kept step with industry progress**

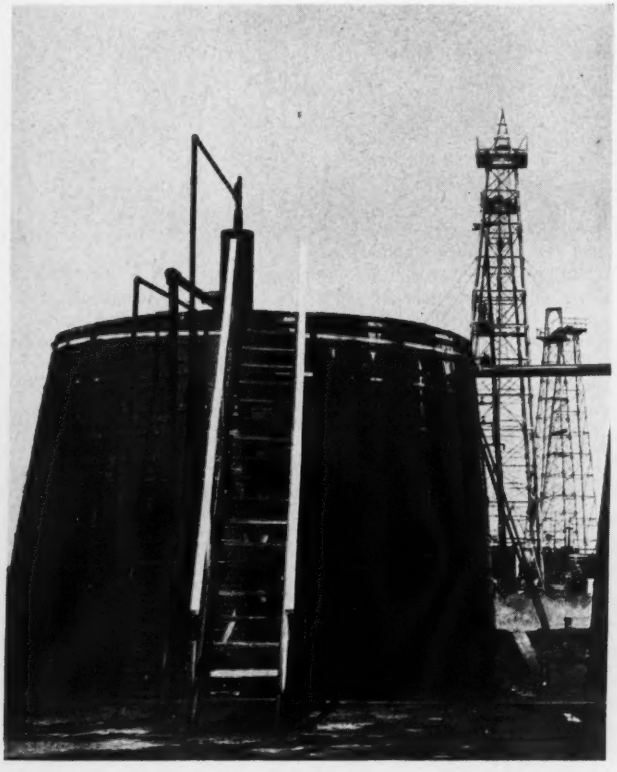
THE practice of storing up surplus goods against the time when they will be needed is as old as mankind, and the manner of storing them is as infinitely variable as man himself. It seems to be almost a matter of instinct, deeply rooted and linked with the basic desire for self-preservation.

As the units of society and government progressed through the ages from family to tribe to nation, the need for storage space increased accordingly. With this progress, it was no longer necessary—nor, indeed, possible—for everyone to supply himself with water and food and the other necessities of life. Reservoirs and granaries and warehouses made it possible for a few people to supply the needs of thousands, freeing those thousands to contribute in other ways to the growth and welfare of their communities. In such manner, then, has the growth of storage facilities and techniques had a direct and profound effect upon our world's social and economic orders.

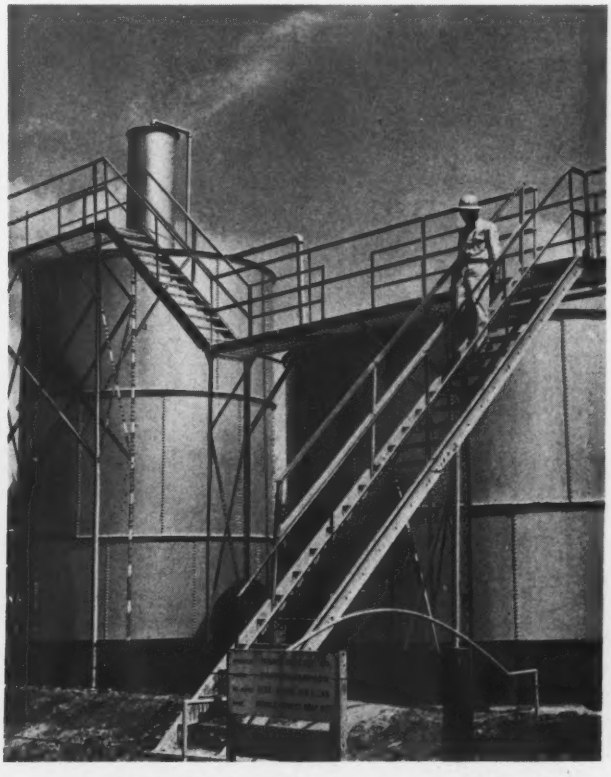
With the rise of industry after the so-called "industrial revolution" of the early 19th century, the storage problem became more complex. The need was for places to put surplus raw materials, goods in process, and finished products. Since these goods and materials differed widely, each new industry had to work out its own storage plans, its own storage problems.

In the infant petroleum industry, for example, crude oil from early producing wells was first stored in simple earthen pits. From there, a process of evolution led to the use of concrete- or wood-lined pits, then to wooden tanks

LIQUID LEVEL in an onion-shaped spheroid may be checked by looking into gauge glasses staggered up side of tank. There is also an automatic gauge at the top. Tank holds low pressure products. Stairway seems to curve into space, actually leads to safety valves at top.



WOODEN TANKS, in the evolution of oil storage, were just a step or two up from earthen pits. Blackened with the oil of four decades, tanks like this still serve well in the Goose Creek field, near Houston.



MODERN PRODUCTION TANKS of welded or riveted steel show results of good housekeeping in today's fields. Gleaming in coats of aluminum paint, they hold from 100 to 1000 barrels of crude oil each.

**WEBSTER TANK FARM** and pump station near Houston, largest in Humble system, is focal point for main pipe lines. Tank in right foreground and several others are floating roof type. Total capacity of the 761 tanks in Humble Pipe Line system is 32,000,000 barrels.

and finally, to larger and more durable steel tanks. Wooden "barrel stave" tanks may still be seen in some of the older oil fields, but they are rapidly going the way of the mustache cup and the Dodo bird.

In today's fields, wells produce and discharge oil into batteries of squat steel lease tanks; each tank holding from 100 to 1000 barrels. In these fields will also be found that type of storage tank which most people have come to associate with the industry—a huge cylindrical reservoir of welded or rivted steel, 30 or 40 feet high, up to 140 feet across, and holding from 55,000 to 140,000 barrels each.

But oil does not remain long in field storage. Like the first little pig in the nursery rhyme, it must go to market. As it does so, it is sometimes temporarily sidetracked at pipe line pump stations, where there are concentrations of tanks in areas called tank farms. The capacity of a large tank farm may run into millions of barrels.

End of the line for most of this crude oil is a refinery. Here is perhaps the best place to see all the various types of storage tanks together, because storage of intermediate and completely refined products is a far more complicated matter than storage of crude oil. The many shapes and sizes of tanks at a place like Humble's Baytown refinery create an impression of jumbled variety. Like the Pied Piper of Hamelin's rats, there are "great ones, small ones, lean ones, tawny ones, brown ones, black ones . . ."

Refining processes today are not nearly so simple as they once were. Through the years, new processes have been developed and new products are still being made. To take care of these, it has become necessary to improve storage techniques and to re-design storage facilities to suit each changing need. During the past few years, for example, the increased demand for lighter, more volatile fuels has increased production of pentanes, butanes, propanes, and other light ends. Storing these in the old-type tanks would have been about as prudent as putting a lion in a paper cage. Tank designers went to work and came up with a sphere, or ball-shaped vessel, inside which vapor pressures are

ACRES OF TANKS of all shapes and sizes serve Baytown refinery. The storage capacity of 774 tanks in the refinery system is more than 21,000,000 barrels of oil and products. In addition, more than 200,000,000 pounds of chemicals essential to refinery operation can be stored.

equal in all directions. Spheres bubble out of the refinery landscape like great silver blisters.

A spheroid, or modified sphere, was developed to handle low-pressure products; those with pressures up to 15 pounds per square inch. From the appearance of some of these spheroids, it would seem that their designers were more whimsical than practical. Nothing could be farther from the truth. Each type has a real and definite use; its unusual shape was designed to do a specific job, not to give tank builders a new toy to play with. Some of them look like the tired, partially-deflated balloons small boys bring home from circuses; others look for all the world like mammoth onions or tomatoes.

Sales storage completes the picture. Finished products, moved from the refinery to points of sale, are stored for a time in wholesale and retail storage tanks. Wholesale, or bulk stations are served by horizontal vessels, each one raised on steel supports and usually labeled at either end with the trade name of the product it contains. Gasoline goes underground at retail service stations; lubricating oil is housed near the driveway in dispensers called "lubsters" or is sold from individual quart or gallon cans.

So it is that tanks have kept step with a steadily-growing and ever-progressive oil industry. Today, they serve the industry in much the same manner that banks serve the financial world. Oil and its products are put into tanks on deposit, to be drawn out as needed, just as funds are deposited and withdrawn from banks. Without these tanks, the industry could carry on nothing more than token operations. Producing wells would operate intermittently, discharging oil into pipe lines by an irregular and expensive batch method; pipe line pump stations would move oil only when it was ordered at distant points, would lie idle when it was not; refineries would shrink to a fraction of their present size.

The implications are staggering. One might as well ponder a world without banks, where everyone would carry with him enough cash to handle every business transaction.

INTERESTING PATTERN IS FORMED BY BOOKS WHICH LIST ROYALTY OWNERS AND EXTENT OF EACH LEASE INTEREST

# Checks Go Out

**Almost 60,000 persons and companies who have interests in leases where Humble buys oil and gas get their monthly checks regularly, on time**

ONCE a month, almost 60,000 royalty owners and producers of oil and gas find in their mail the familiar window envelope which bears a Humble check.

These checks run all the way up and down the financial scale. In a few cases, it is true, a single check would establish financial security for the average family. But many of them would have to be stretched to pay for a month's groceries, and there are still others that would buy a cup of coffee and leave nothing for doughnuts. Two things account for the wide spread between these two extremes: volume of production, and the extent to which royalties have been divided.

By no means all of these checks are royalty payments on Humble-operated leases. Thousands of them go to other producers and royalty interests, for Humble's operations are such that the Company buys as much oil from others as it produces from its own wells, sometimes more.

While the majority of these 60,000 persons and producers have been getting their monthly check from Humble regularly and on time for years, there are others for whom the white envelope and its cherry-colored check hold a "first time" thrill. In any case, regardless of amount, there is a world of work to be done before checks are ready for mailing, for small ones require just as much handling—and get just as much attention—as big ones. Obviously, this is a job that calls for not one, but many, well-trained organizations — all of them coordinated and dedicated to the single task of getting the right check to the right person, regularly and on time.

It must be understood, to begin with, that the matter of arranging payments for oil and gas produced from a tract of land is quite different from handling payment for, say, cotton and corn produced from the same land. Certain—and sometimes quite complicated—legal procedures are necessary.

First, before anyone can be paid, titles must be cleared to establish ownership of oil and gas on every lease. That done, Humble prepares *division orders*. These orders are really buying-and selling contracts; they give the names of producers and royalty owners on each lease and set forth, down to the

smallest fraction, how much of the total value of the oil and/or gas shall be paid to each interest. Once titles are cleared and division orders are issued and signed by each interest owner, the accounting machinery for monthly payments can be set up.

Bases for routine monthly accounting are the daily run tickets (showing how much oil and gas is run every day from each lease) sent in by field gaugers. These tickets are translated into barrels of oil or thousands of cubic feet of gas and finally into dollars and cents. Of course, this makes it necessary to keep books on every lease tank and every person or company from whom Humble buys oil and/or gas.

When the monthly totals are completed for each lease, value of the oil and gas is computed by separate groups, checks are audited and proved correct by another, and still another group mails the checks to their owners. It would seem to be a case of too many cooks—but in this case it serves to make a better broth.

Humble's Division Order and Title Division is the seat of control for all payments. It is through this group that titles are cleared, ownership of oil and gas is established, and division of interest is made. Obviously, this is work which calls for constant excursion into the field of human relations, both by person-to-person contacts and by correspondence. In fact, there is a variety of interesting background material on human behavior to be gathered from work in this division—material interesting enough to delight the most enterprising playwright.

Dealing as they do with the myriad complexities arising from thousands of leases, employees of the Division are confronted daily with some of the personal problems of royalty owners. The solution of these problems calls for courtesy, diplomacy, understanding, and a deep sense of responsibility. The Division is concerned, too, with the vital statistics of marriage, divorce, and death. Every transfer of interest, every sale and purchase of royalty interest is shown on their books, and many of these transactions bring in new problems. It is well, therefore, that employees in this Division set up for themselves a standard of conducting business which would do credit to the sympathetic ear of Mr. Anthony, the wisdom of Solomon, and the patience of Job. No problem is too small, no question too trivial, to receive their complete and courteous attention.

In the files of the Division Order and Title Division are the names of everyone from whom Humble has bought a barrel of oil or a cubic foot of gas. New names, of course, are constantly being added; others are constantly being removed to the inactive file. It appears nothing short of miraculous that the Division can keep up with changes at all, considering the rate at which royalties change hands through purchase and inheritance.

Let us say, for example, that Mr. John Doe has a full 1/8 royalty interest in oil produced from his land. Friends, neighbors, and just plain investors seek out Mr. Doe and buy interests in his royalty. Perhaps he will sell 1/16 of of his 1/8 to one person, 1/4 of it to another, 1/64 to still another, and so on; there is practically no limit to these subdivisions of interest. And the picture is still further complicated when Mr.

YARDS OF PAPER are sometimes required to list all the royalty owners on a single lease. This division order, covering a gas lease in the Katy field, near Houston, carries 700 names.

COMPTOMETER OPERATOR in Oil Run Division uses tank tables and temperature compensation chart to translate data sent in on gauger's run ticket into barrels of oil. To get total value of oil run, the number of barrels is multiplied by the posted price per barrel.

OPERATORS of combination typewriter-multiplyer machines complete monthly farm ledger for each lease. Ledgers carry names of royalty owners, plus each owner's share of oil expressed in decimals. Machine computes and records money value of each decimal interest.

Doe dies and leaves his remaining royalty to be divided among 10 surviving children. With each subdivision of interest comes new work which is reflected all down the line in every organization connected with preparing, processing, and mailing checks.

If production at the Doe lease proves good, everyone concerned has a good chance to make money. But not always so. Royalties are sometimes split so thin that investors, especially on some marginal leases, may be credited with only a few cents—or a fraction of a cent—a month. In one actual case, a royalty interest amounts to only 1/58,000,000; that is, the royalty owner gets only one barrel of oil in every 58,000,000 produced from that particular lease.

There are thousands of other cases, not so extreme, where the royalty is divided so many ways that it takes all the skill of experienced accountants to keep up with them. For example—and this case is by no means unusual—an individual interest in one section of the Katy gas field near Houston amounts to 1/32 of 36.74/789.23 of .0424833 of 1/8. That same person has 19 similar interests in different tracts of the Katy field.

None of the foregoing, of course, is to imply that everyone who has interests in oil royalties receives a small check every month. Quite the contrary; some considerable fortunes have been built up around oil and gas royalties. The great majority of royalty checks, however, are at neither end of the scale; most of them fall within the middle income group.

Tabulating and recording the volume and value of oil purchased on division orders each month are jobs which lie within the province of Humble Pipe Line Company's Oil Run Division. Field gaugers send their daily run tickets to this Division, where machine operators, with the help of conversion tables and other data, translate tickets first into barrels of oil and finally into dollars and cents.

A "farm ledger" is set up by the Division every month for every lease. At the end of the month's business, each ledger will show the total value of oil run from that lease, the amount of state taxes deducted, the names of producers and royalty owners to be paid, and the amount each will receive.

There are in the Oil Run Division's files the names of some 125,000 persons and producers. Since oil will not be run from every lease every month, only 40,000 to 50,000 of these names, called "open accounts," will be active in any one pay period. Checks for open accounts are rocketed through an automatic addressing machine at the rate of 110 a minute.

Addressed checks go to the Treasury Department accompanied by a check register, or master sheets bearing lists of interest owners and amounts to be paid. Three check-writing machines—two for oil and one for gas—are kept busy for ten days to two weeks each month, filling in the amount of money and the authorized signatures on each check. These are no ordinary check-writing machines. First, they are set at zero by representatives of the Comptroller's and Treasury Departments. As they go into operation, they tabulate the number of checks going through; record a continuous money total like a

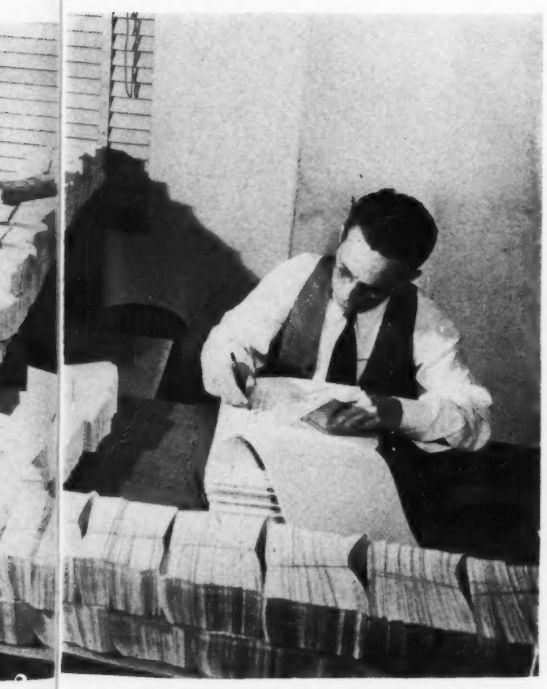
HOW MANY CHECKS are still outstanding (not yet cashed) from last month's payments?

STACK OF CHECKS is fed into addressing machine which rockets them through at 110-a-minute rate. Name plates for inactive royalty interests during the month are so arranged that machine makes blank run on them, resumes printing when next active name appears.

THREE CHECK WRITING machines in Treasury Department are kept busy making out almost 60,000 checks a month. In one operation, machines count checks going through; print date, check number, amount; sign two signatures; check against pre-determined totals.

car speedometer records mileage; print the date, check number, and amount; and sign two signatures to each check. While the lower section of each machine is busy with these jobs, the upper section prints check numbers and amounts on the master register. All operations are simultaneous.

For accuracy, each machine total is checked against a predetermined total.



Audit Section of Treasury Department knows the answer, keeps bank books in balance.

Completed checks are sent to the Treasury Audit Section, where totals are verified. It is also the duty of this section to reconcile the Company's bank accounts after paid checks are returned. Now the checks are ready for the Crude Oil Accounting Department.

One of the many interesting functions of the Crude Oil Accounting Department is keeping records on some 5500 to 6500 "suspense accounts" every month. Accounts may be held in suspense for only a short time, for a few months, or for many years, depending on the circumstances. They fall into three broad groups: (1) those which cannot be paid until litigation has been cleared up, or until title requirements have been satisfied, (2) those on which monthly accruals are so small that royalty owners have instructed Humble not to send a check until one dollar has been accumulated, and (3) accounts of non-resident aliens—those the Department calls "NRA."

Non-resident alien accounts are on file for residents of many foreign countries. In paying them, the Department deducts an amount of federal withholding tax in accordance with reciprocal agreements between the United States government and the country in which the royalty owner lives. Checks for NRA accounts are mailed as soon as they can be prepared and cleared through the necessary channels. Besides these, other suspense accounts are continually being cleared up and checks are issued daily.

The Crude Oil Accounting Department carries on considerable correspondence with interest owners. Many of these letters are in answer to questions about suspense accounts; others are concerned with checks which have been delayed or which owners have lost. As a last resort in some cases, the Crude Oil Accounting Department requests that the Treasury Department give the bank a stop-payment order on the original check. A duplicate check is mailed as soon as it is authorized by the Treasury Department.

Still another responsibility of the Crude Oil Accounting Department is to compare every name and check with the name and amount as indicated on the Master Oil Run Statement, which is really a reproduction of the farm ledgers.

Finally, the checks' Houston office odyssey is complete, and the Crude Oil Accounting Department mails them to their owners, each check accompanied by an oil statement showing purchases from that particular lease. Those who have interests in more than one lease get a separate check for every lease.

Even now, there is no breathing period for any of the groups concerned with getting checks to royalty owners. With one month's business out of the way, it is time again for several hundred employees in all these groups to begin the next month's work.

# The Search for OIL

By OLIN G. BELL
*Production Geologist, Gulf Coast Division*

**Production geology begins with drilling of wildcat, ends with maximum oil and gas recovery from field**

THE climax in the quest for oil is the drilling of the exploratory or "wildcat" well. It is the "proof of the pudding" to determine whether or not oil or gas actually exists where the evidence accumulated by the surface and subsurface geologists, the paleontologist, the geophysicist, the scout and the landman has indicated a good possibility. This final test can be made only by drilling one or more wells on the prospect.

The application of geology and the function of the geologist do not cease with the drilling of the wildcat well, however, but continue on through the development of the newly discovered field; the search for and development of extensions and deeper pay horizons; the performance of any remedial work necessary in the field; and the conduct of reservoir and other analytical studies of the field in cooperation with petroleum engineers. In short, the application of geology continues from the first search for prospective areas through its entire productive history to the ultimate recovery of all the oil and gas possible from the field. From the planning of the wildcat on through to the exhaustion of production the geological work is performed by the production geologist.

Drilling operations are performed by the production department, and all mechanical and operational problems connected therewith are handled by the field and supervisory personnel of that department. The production geologist performs the geologic work associated with the operations and acts as a liaison between production and exploration departments, in a cooperative and coordinated project.

When the time has arrived to drill the first exploratory test the production geologist prepares the "on-the-well" geological program for that test. He reviews and utilizes geological information from all sources available on the formations to be encountered, their estimated depth, thickness, and characteristics; the estimated depth of possible productive zones; and other information pertinent to the problems anticipated in drilling the well. This includes a preliminary program for logging, coring, and testing prospective sands.

He also reviews this information with the petroleum engineering section of the production department so that this section and other sections of the department can plan operations according to the program. This is true particularly as it applies to size of rig required, roads necessary, source and type of fuel, water supply, size of hole to be drilled, size, weight, and lengths of casing strings to be used, preparation for handling any unusual mud conditions, high pressures and other unusual drilling hazards.

As drilling progresses the production geologist has an electric log made at prearranged depths. The chart of the electric log shows on one side the resistance of the different strata to an electric current introduced into the hole from the surface, and on the other side a curve representing the measurement of electric potentials inherent in the rocks. These two curves give a clue to the nature of the materials composing the rocks penetrated, and in some instances furnished an index to the type of fluids contained in the porous zones. The production geologist studies critically and analyzes this log for correlation with other wells which may have been previously drilled in this general area, for identification of formations penetrated, for indications of any possible pay zones which have been found, and for guidance in revising his subsequent logging, coring, and testing program.

During the drilling operations cuttings are chipped off as the bit grinds its way through the formations and are pumped to the surface in the circulatory mud stream. These are separated from the mud and collected at regular intervals. The production geologist makes a preliminary study of these for recognition of fossils found in them and for identification of the zones or formations encountered. This "in-the-field" paleontologic examination of the cuttings gives the geologist prompt identification of the formations and provides advance information prior to running an electric log which he can quickly correlate with the data derived from the electric log and other sources. He is thus enabled to revise his program on the well continuously as drilling continues. In some limestone areas these cuttings furnish the principal and most reliable source of information.

When a prospective pay sand is approached the zone is cored, that is, a cylindrical shaped section of the rock is cut with a special bit and is brought to the surface. The geologist examines the cores promptly while they are as fresh as possible and makes a very detailed description of them as recovered from the core barrel. He measures inch by inch the total amount recovered, the percentage of recovery, the depths from which the cores come, the types of sediments, whether sand, shale or lime, and their color, hardness, texture, and all other visible characteristics. His examination also discloses whether there is any oil or gas present.

A fluoroscope lamp is of much help to the production geologist in detecting the presence of oil in cores. Since oils are fluorescent under ultra-violet light, a portable unit containing such a lamp is used at the well to detect even minute quantities of oil in the cores. While this examination does not indicate accurately the percentage of saturation it is highly useful to him in deciding whether to make a drill-stem test, to core deeper, to set casing, or otherwise to plan the next immediate step in his program.

If this visual examination indicates a show of oil in the core he makes a "boilout" test which gives him an idea as to the quantitative value of the show. If he is not sure that a satisfactory oil or gas well can be completed, a "drill-stem test" of the zone may be made. This test usually answers the question.

If any parts of the core show oil or gas, suitable samples are prepared and sent to a central laboratory for permeability and porosity analyses. Permeability is a measure of the ability of a porous rock to allow a liquid or a gas to flow through it. A rock may be porous, but if the pore spaces

are not inter-connected or are so small that liquids or gases pass through them with difficulty, the rock has no, or very low, permeability. These data are valuable to the Statistical and Evaluation section in the estimation of reserves. It is also very useful later in reservoir studies of the field and in consideration of any repressuring, recycling, water flooding, or other remedial or secondary recovery projects.

As already stated, when cores indicate a show of oil or gas, a drillstem test is often desirable to determine the productive possibilities of the zone. The geologist advises the production department at what depth the test should be made, how thick a zone should be tested, where the best packer seat or seal to shut off the drilling mud can be obtained, and the type of test desired. He also observes the performance of the test and the result. From this he recommends whether or not casing should be set and a completion attempted in that zone or whether the zone should be held in reserve for later completion through perforated casing.

Bottom hole pressure data obtained from the drillstem test are also useful to the production geologist and the petroleum engineer in analyzing subsequent performance, in planning later remedial measures, and in reservoir studies in the field.

After the discovery well is completed and production is established, development of the field follows. The production geologist assists in planning the spacing pattern and arrangement of wells on the leases and in the field, and assists in planning the entire development program. This entails the preparation of a structural map of the field and its constant revision as drilling progresses. The map enables him to select the best sites for locations; to anticipate the depths of pay sands; to prepare the logging, coring and testing program on each well as drilled; and to detect the presence and effects of any faults present and their direction, angle, and magnitude of displacement. In short he applies the same geologic practices to each field well as he did to the discovery well.

During the productive life of a field many of the wells, and eventually all, begin to fail in their performance. Water encroachment, gas encroachment resulting from high gas-oil ratios, sanding up, mechanical troubles, and eventually depletion are common ailments. It is the function of the production geologist to watch the productive performance of each well and as any of these troubles develop to prepare a "work-over" or remedial program. This may involve deepening the well to a new sand, plugging back to an upper member of the same sand, or plugging back to a higher sand. Each well and its case history must be studied individually and its corrective program worked out accordingly.

In effect, then, the production geologist is the one who follows through in the program of exploitation from the drilling of the wildcat well which proves the presence of oil until the last recoverable barrel has been produced. He is designated by some companies as an exploitation engineer, by others a sub-surface engineer. He was formerly termed "well-sitter" because he would sit on a well during its drilling. His function, however, has been expanded during the past fifteen years and his responsibilities greatly enlarged.

He is truly a geological engineer. Since he works between the exploration and production departments he must be not only an experienced geologist, but must also be thoroughly familiar with the problems, techniques, and methods of the production department. Only when so prepared can he outline and prepare a drilling, coring, testing, and completion program suited to meet the drilling conditions encountered. It is, therefore, highly desirable that each production geologist, after having received his fundamental training in geology and geological engineering, work for a period of several months as a member of a drilling crew. Simply another practical application of the old adage that there is no substitute for experience.

An appropriate analogy may be drawn between the work of the production geologist and the physician. The physician watches his patient; studies and diagnoses his ailment and its symptoms; prescribes the necessary medicines, operations, and curative program; and alters it from time to time as the patient's reaction changes. The physician may be called at all hours, day or night, in all kinds of weather, sometimes over almost impassable roads. It matters not whether he has had his rest; his prime interest is the care and comfort and recovery of his patient.

So it is with the production geologist. He likewise looks after his patient, the drilling well, at all hours of day or night. Weather and road conditions matter little. He snatches

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DRILLING MUD is washed from the cuttings before they can be examined for micro-fossils.

CUTTINGS ARE examined in field laboratory for micro-fossils; sometimes rocks, minerals.

FRESH CORE is emptied from core barrel. Geologist is on the job to examine specimens.

BOIL OUT TEST is made by the geologist on a sample of core just taken from the well. At the left, two geologists study a freshly made electric log, which reveals something of the subsurface into which new well is being drilled. On-the-job decisions must be made promptly, and this log is being compared with the logs of other wells drilled nearby.

a little sleep when he can in his car or in a trailer provided at some rigs for emergency use of visiting employees. His prime interests are the successful completion of the well, and a long productive life for it.

Each production geologist is usually assigned an area or district in which he operates. In this area he is responsible for all exploitation work. He works from a field office and laboratory located in a field or camp accessible not only to that field but also to any wildcats or other fields which are assigned to him. This field laboratory consists of two rooms: one serves as an office and the other is equipped with facilities for washing, drying, screening and studying cuttings.

Here the geologist examines cores with greater exactness than at the well; here he keeps his files, maps, cross sections, charts and logs, as well as equipment and supplies he needs.

During the drilling operations of any well, either a wildcat, field wildcat, or field well in a proven area, the geologist keeps a detailed record of all data pertinent to that well. This is information which may be useful in many ways—in determining what the next step in the immediate program should be, in handling the well when it is first completed, in planning a future workover job which may become necessary to restore it to profitable production. This information is compiled at the termination of the operations in a *completion letter* which is a case-history of the well from its start to its finish. The geologist's interpretation of the information is recorded. It is prepared in such a way that any other geologist, later studying the well or the area, can readily understand it and will have all data available which may be useful to him. The preparation of this letter is regarded as second in importance only to full and proper observation and use of the data as the well is being drilled.

In addition to keeping in close contact with the operating force on the well, it is also essential that the production geologist know the personnel of companies which perform these services; electrical logging, core analysis, drillstem testing, gun perforating, and similar operations. He must likewise keep in touch with the office staff of the field as well as the division personnel in the main office.

Because the work is one of close coordination it is the normal practice for the geologist to have frequent, often daily, conferences with the field superintendent and other members of the supervisory staff. Similar conferences are often held by telephone with the division office.

There are a number of technical services performed by companies specializing in certain activities connected with oil well drilling, such as electric well logging, gamma-ray and neutron logging, caliper surveys, temperature surveys, dipmeter surveys, deviation surveys, and others. The geologist is vitally concerned with all of these, more especially with the electric log, gamma-ray log, dipmeter survey, and deviation surveys. The others are of equal or more immediate importance to the petroleum engineers.

In the case of the electric log, for example, the production geologist decides at which depths the well will be logged. He is then on the well at the time to examine the original film of the log as soon as made to study and analyze it, to correlate it with logs of other wells nearby, if any, and to plan his next step in the operation of the well. This log may indicate to him whether or not he should take sidewall cores, begin a wire-line coring program, prepare to set casing, or to abandon the well as a dry hole. Later, copies of the log are made from the film and distributed to others who use it for subsurface and other studies.

There are still other specialized services exceptionally useful to the geologist which are rendered by companies equipped to perform them on the well while drilling. Not only on the job but also in later studies and analyses are these data useful. This is especially true of core examination on the well and use of a "mud logger" unit. The geologist uses and correlates the information as soon as obtained.

A special portable field laboratory, containing the equipment necessary to make special studies of the cores is used at certain wildcat locations. These trucks contain equipment for

AFTER THE OIL in a core is dissolved out with pentane, the solvent is evaporated by using the heat of the boiler feed pumps. The oil left as a residue in the flask is an indication of the degree of saturation of the core. At right, the fluorescent quality of oil enables the geologist to detect minute quantities of oil in a core under ultraviolet light.

making reliable permeability and porosity determinations, saturation tests on the cores, and estimates of the gas, oil, and water content of the sand. Sometimes, however, the cores are coated with paraffin or sealed in jars, and then are sent to a central laboratory for the same determinations as made in the field units.

A process for quick freezing the cores of the job as taken was patented recently and is being used. Quick freeze boxes, using carbon dioxide as a freezing medium, are taken to the well beforehand and the cores, as soon as extracted from the core barrel, are frozen and sent to a central laboratory.

Likewise, on some wildcats, particularly where shows of minor importance are likely to be encountered, and where shows of gas may be found which might be difficult to recognize by ordinary methods, a "mud logger" truck is brought to the location. Drilling mud, as it is circulated into and out of the well, is studied. Here again the truck is in reality a mounted or portable laboratory fully equipped for making all the determinations contemplated on the location. The personnel is highly trained in the manipulation and use of this equipment and in making the analytical studies required. The drilling rate, or speed of penetration of the drilling bit into the formation is recorded; any shows of gas which are returned to the surface in the mud are measured and recorded automatically by means of an electrical device; and any shows of oil are determined by the operator by taking samples of the mud at regular and stated intervals and examining them under a fluoroscope. This type of equipment is used almost exclusively on wildcats and semi-wildcat jobs.

Individual leases in a field often are smaller than the drilling units most suitable for development of the reservoir. In such cases it is frequently necessary or expedient to consolidate several smaller leases or parts of leases to form drilling units of suitable size or shape or position on the structure. The proper arrangement of drilling units of this nature involves a careful geological study of the field with due consideration given to the sands, sand thicknesses, and other reservoir characteristics. It is a function of the production geologist to confer and consult with supervisory personnel in the exploration department in planning such projects. This is a cooperative program between the production geologist and the land and title men concerned.

In many gas fields there are thin oil zones or gas condensate zones in which no low ratio wells can be completed as such. Therefore, to recover the liquid products from the reservoir it is necessary to produce the gas, extract from it the liquid hydrocarbons, and either market the residue as dry gas or otherwise dispose of it. It has been found an efficient practice in many fields, where structural and sand conditions permit, to pump produced gas back into the sand and thereby drive more liquid to the surface. Such a project involves a geologic and an engineering study of the field and its productive characteristics. Here again production geologists, petroleum engineers, and supervisory personnel collaborate.

After production has been established in a field and its development fully or partially complete, reservoir data on the field are compiled. This includes each producing horizon and segment, the producing characteristics of each well, including bottom hole pressure, gas oil ratios, encroachment of water, characteristic of the gas and gas cap, and all other pertinent information. A general study is then made of the reservoir itself, including all of its idiosyncrasies, with a view to determining a production policy for the most efficient operation of the field and each horizon therein. Such a study is not only necessary to determine the best productive procedure for the field but also to ascertain whether or not recycling, repressuring, water flooding or other secondary recovery methods could or should be installed. Such an analysis requires a large amount of work and involves both geologic information and engineering data and is therefore a joint or cooperative project for the field in which both the production geologist and the petroleum engineer operating in the field collaborate.

# By the way . .

### Earned Rest

Since early this year 24 Humble employees either have reached normal retirement age or have taken advantage of the early voluntary retirement feature of the revised Annuity & Thrift Plan. The time order in which these employees have closed out their active careers in favor of a life of deserved rest is as follows: On January 10, CHESTER W. CLEVELAND, pipefitter first class at Baytown refinery, joined the ranks of the retired . . . on January 11, THOMAS J. LAMB, Production department pumper in the Holliday district . . . on January 12, JIM JOHNSON, laborer at Baytown refinery . . . on January 16, MAT H. WILKEY, guard at Baytown refinery . . . on January 17, JOHN HOYLE, teamster at Baytown refinery . . . on January 22, HOWARD L. BLACK, Production department lease pumper and gauger in the London district . . . on January 21, SAMUEL L. USERY, stock gauger at the HPL Fairfield Station . . . on January 23, RAYMOND E. SWARTZ, Building Maintenance department, Houston Office . . . January 30, RUCKER P. ELLISOR, handy repairman at Baytown refinery . . . on February 1, two Baytown refinery employees: JAMES D. HUNNICUTT, chief investigator, and GEORGE H. SPRUCE, rate check and time posting clerk . . . on February 5, WILLIAM LODGE, Building Superintendent, Houston . . . on February 7, ROGERS HOBBS, laborer at Baytown refinery . . . on February 14, DEWEY D. WALKER, oiler at HPL Webster Station, and THOMAS R. BOUNDS, Production department district superintendent at Thompsons . . . on February 16, JOHN F. STOUT, second class helper at Baytown refinery . . . on February 24, HARRY H. KILGORE, first class pipefitter at Baytown refinery . . . on February 26, BILL SPENCER, pipe liner at HPL Ingleside Station . . . on March 1, ALICE M. LEONARD, Building Maintenance department, Houston, and MAE STEEN, clerk and cashier in the Treasury department, Houston . . . on March 12, WILLIAM R. SCHROCK, handyman at Baytown refinery . . . on March 22, ALLAH R. CALAWAY, pipe liner at Harbor Island . . . and on April 12, HENRY BEHRENS, handy repairman at Baytown refinery.

### Two-Year Index

An index covering articles, paintings, and color photographs appearing in THE HUMBLE WAY during the past two years is now being prepared. Both topical and alphabetical listings will be included to make cross reference easy and quick, and the complete index will be printed in such form as to make it suitable for binding with copies of the magazine. All subscribers will receive through the mail at an early date a reminder about this index and an order form.

### Employee Deaths

Eleven employees and one retired employee have died since our last report of employee news in these columns. ALBERT H. GRAFF, 39, gas plant operator at Katy Cycling Plant, died on January 17 . . . FRANK J. KULAK, 46, helper at Baytown refinery, on February 12 . . . MALCOLM M. GRAHAM, 48, analysis clerk in Sales Accounting, Houston, on February 18 . . . CLYDE L. SETTLE, 27, first class welder at Baytown refinery, on February 19 . . . ORIEN C. BREWER, 48, warehouse supervisor at the Specialty Products plant, Houston, on February 25 . . . ARCHIE BELL, 43, laborer at Baytown refinery, and ALFORD TAYLOR, 48, porter at Baytown Bulk Station, Sales, both on March 2 . . . KIRBY B. CHANCEY, 42, assistant district gauger in Humble Pipe Line Company's Anahuac district, on March 3 . . . J. C. LOTT, 33, laborer at Baytown refinery, and EDWARD J. SAWBERGER, 50, first class machinist at Baytown refinery, both on March 7 . . . and ROY GLEN FRYE, 43, quarterboat supervisor in the Production department's Bayou Sale, Louisiana, district on March 27 . . . THOMAS C. WILSON, pipe liner in the Pierce Junction district until his retirement several years ago, died on February 27.


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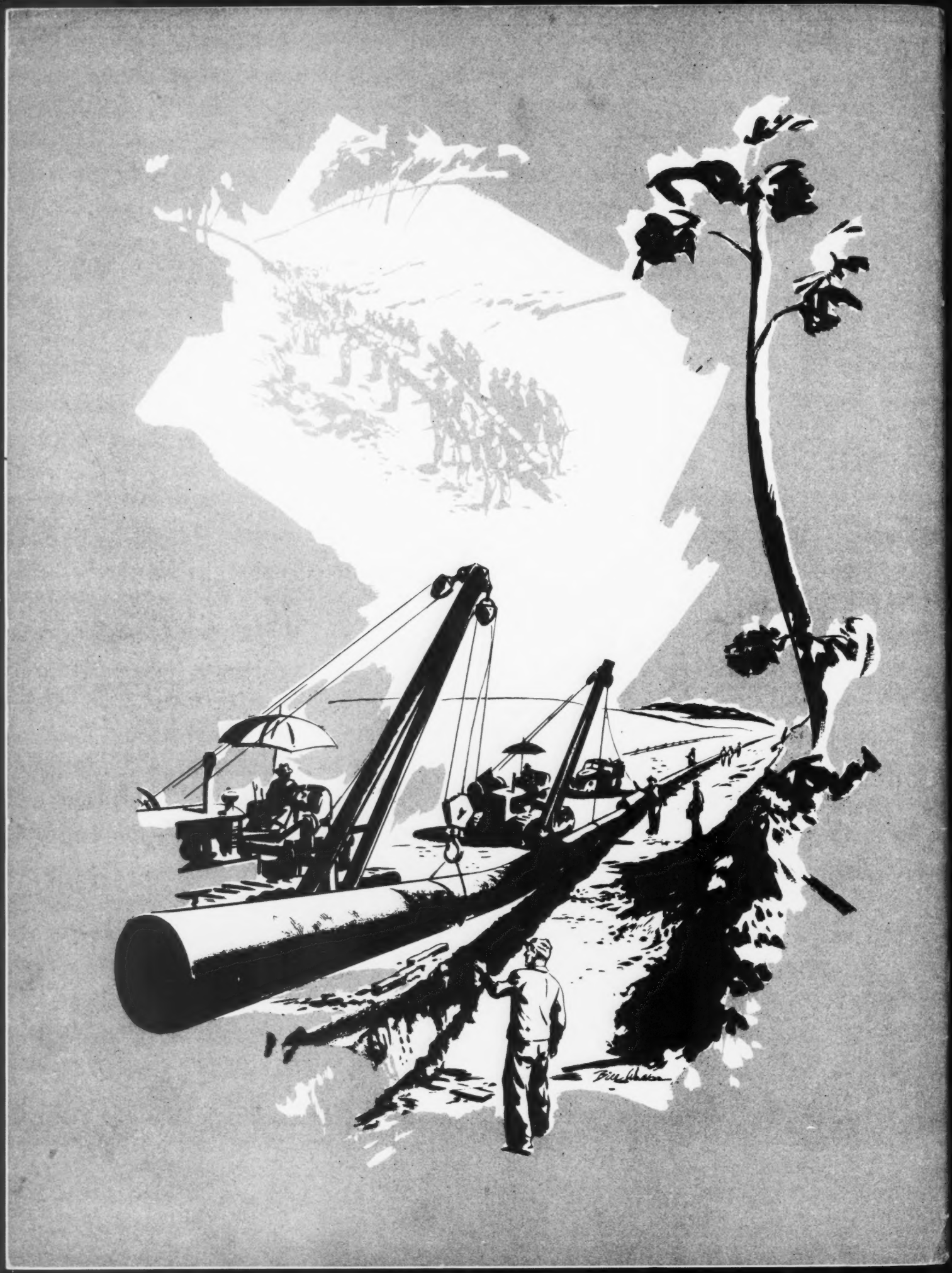
### The Cover

This month's cover painting by E. M. Schiwetz depicts a scene that has been rather common in the Gulf Coast area—cattle huddling around an oil field gas flare in cold weather. As the post-war gas conservation program progresses, however, the number of flares is being reduced sharply; in many areas gleaming oil storage tanks dotting farms and ranches are the only surface evidence of an oil field's existence.



SURVEYOR AND DRAGLINE dominate this construction scene at site of the Humble-Quintana gas plant being built near Refugio to conserve casinghead gas. (*Farewell to Flares*, Page 9).